CENSUS OF EUROPEAN STORM-PETRELS *HYDROBATES PELAGICUS* ON SKOMER ISLAND

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Brown, J.G. 2006. Census of European Storm-petrels *Hydrobates pelagicus* on Skomer Island. Atlantic Seabirds 8(1/2): 21-30. *Comprehensive tape playback surveys were carried out in 2003 and 2004 in order to provide repeatable estimates of the number of European Storm-petrels* Hydrobates pelagicus *breeding on Skomer Island. This included the measurement of response-rates by repeated visits to two sub-colonies, one each year. In 2003, the cumulative number of Apparently Occupied Sites was still increasing on the 11th and final visit, and so the data were extrapolated to predict an asymptote. The 2004 calibration plot levelled out after the 7th visit (probably due to the consistent use of a more effective tape) but the discovery of a new site on the 13th visit resulted in a slightly higher predicted asymptote than that was found. The respective response-rates of 0.27 and 0.44 were significantly lower than previously thought, and thus give higher population estimates when responses were adjusted by the reciprocal correction factors. The Skomer European Storm-petrel population is now thought to be in excess of 300 AOS, and is becoming a significant component of the Skomer and Skokholm SPA (now the population on the latter is apparently declining). Tape quality has a significant effect on the number of responses elicited, which has important implications for future surveys.*

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INRODUCTION

The estimated number of European Storm-petrels *Hydrobates pelagicus* breeding on Skomer Island has ranged from 55 to 1200 pairs, using the two apparently incomparable methods of capture-mark-recapture and diurnal tape playback (see Brown 2005a and references therein). Population estimates using playback have previously involved multiplying the number of responses by a 'correction factor' of 1.37, based on the assumptions that 100% of males and 46% of females respond to playback (James 1984), and that both sexes share incubation equally (Scott 1970).

There has been concern raised in some quarters as to the effect of predation by the introduced Little Owl *Athene noctua* on the Storm-petrel population, but any evidence for a decline is inconclusive due to the inherent census difficulties.

In order to monitor the population dynamics of the Skomer Storm-petrel population (and the effects of any future experimental manipulation of the Little Owl population), a repeatable census technique must be developed.

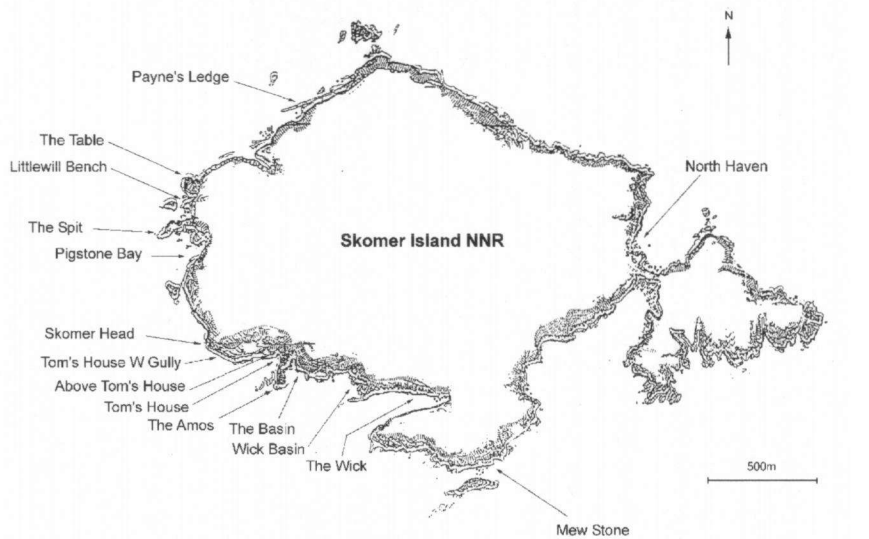

Figure 1. Location of European Storm Petrel sub-colonies on Skomer Island.
Figuur 1. Ligging van subkolonies van Stormvogeltje op Skomer.

In 2003 and 2004 all known sub-colonies and any other suspected areas were searched thoroughly using diurnal tape playback, and response-rates established from repeated visits to selected sub-colonies, with the aim of providing repeatable estimates of the number of European Storm-petrels nesting on Skomer Island (for more detailed reports see Brown 2005 a&b).

METHODS

All known Storm-petrel sub-colonies were visited, and carefully searched for likely nest site entrances. Smell was used to identify prospective nest holes in some instances, but by and large this was found to be very subtle and non-perceptible in many cases. A tape recording of a calling European Storm-petrel ('terr chick' and purring male) was played close to (generally within 10cm from) a prospective nest site entrance on a small Sony cassette recorder at near full volume (what was thought to be close to 'natural' volume) for roughly 30 seconds, and a reply listened for (either a creaky 'terr chick' call, the purring male 'song', or both). Nest-site entrances from which responses were elicited

were individually marked (usually numbered) using paint or Tip-Ex ('correction fluid'). Some markings from previous years were still visible.

2003 In 2003, visits were carried out between 5 and 22 July between 08.30 and 20.00h, except for an early visit to the Mew Stone sub-colony on 23 June, and a repeat visit to North Haven on 14 August to test the effects of a late season visit on adult and chick responses. The Mew Stone sub-colony was visited twice, and Tom's House five times. The mean number of responses per visit was used in the calculation of apparently occupied sites (AOS) for these sub-colonies. Other potential sub-colonies (except North Haven) were visited just once.

2004 In 2004, the bulk of the work was carried out from 2-16 July, with three other potential sub-colonies ('Above Tom's House', Amos and 'Tom's House West Gully') checked on 26 and 31 July respectively. Two visits were made to the Mew Stone, and other sub-colonies (apart from Tom's House, see below) were visited once only.

Measurement of response-rates In 2003, the North Haven sub-colony was chosen as a calibration site, as it is a compact area of homogenous habitat which could be checked thoroughly and relatively quickly. Eleven visits were made between 5 and 22 July, with an additional visit on 14 August (see above). An effort was made to vary the time of day for each visit and the tape used. Nest-site entrances from which a response was obtained were numbered with Tip-Ex.

In 2004, the Tom's House sub-colony was selected, to provide a contrast in habitat (Tom's House is a natural boulder beach while North Haven is a man-made stone-clad bank) and geographical spread (the two sub-colonies are at opposite ends of the island to each other). Tom's House is also one of the sub-colonies where access is more straightforward. Fifteen visits were made between 2 and 16 July, between 10.35 and 18.50h.

Tapes In 2003 the following tapes were used, in the case of Tapes 1 and 2 because they were present on the island and had been used in previous playback. Tape 4 was only acquired in the third week in July:

- Tape 1: loop tape from Warden's office with quite loud, harsh, sharp, predominantly 'terr chick' with some purring. Source unknown.
- Tape 2: recording made from 'Bird Sounds' tape. Soft, somewhat muffled, purring.
- Tape 3: a hybrid of 1 and 2.
- Tape 4: loop recording from CD recorded on Skokholm in 1998. Predominantly purring. Relatively good quality.

In 2004 Tape 4 only was used.

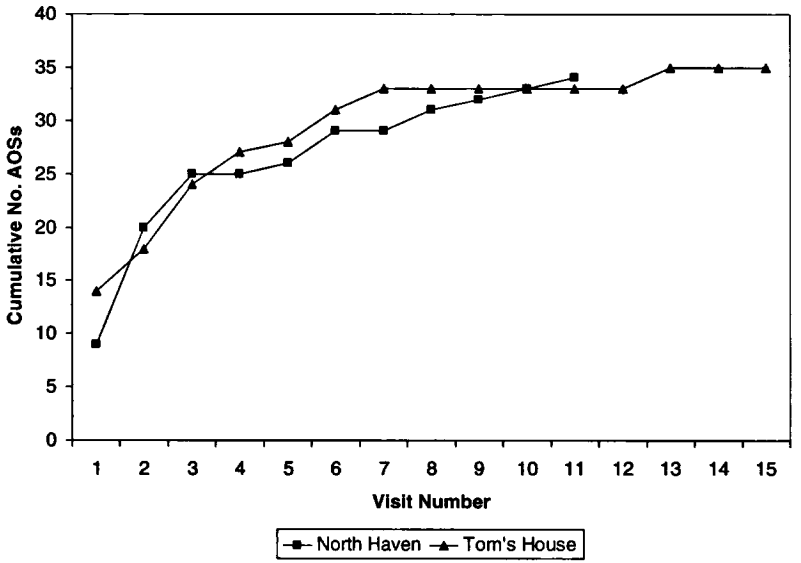

Figure 2. Cumulative increase in the number of Apparently Occupied Sites identified over 11 visits to the North Haven sub-colony in 2003, and 15 visits to the Tom's House colony in 2004.

Figure 2. Cumulatieve toename van het aantal 'schijnbaar bezette nesten' (AOS) tijdens 11 bezoeken aan de subkolonie North Haven in 2003 en tijdens 15 bezoeken aan de kolonie Tom's House in 2004.

RESULTS

Response-rates 34 AOS were found over 11 visits to North Haven, but a new site was still found on the eleventh visit (Fig 2), suggesting that even 11 visits was probably too few to find all occupied sites. In 2004, no new sites were found after the seventh visit (33 AOS in total), until the 13th visit, when two others were discovered (total 35 AOS) (Fig 2). In order to predict asymptotes, i.e. the total number of AOS at each sub-colony, Fowler's (2001) method was used, as recommended in App II of Mitchell *et al.* (2004). This involves the reciprocal transformation of both axes in Figure 2, with the reciprocal of the y intersect the predicted asymptote. (N.B. Mitchell *et al.* actually erroneously state that the y axis is 1 / number of responses, whereas it should be 1 / the cumulative number of responses). Thus, the predicted total numbers of AOS were 50.8 at North Haven in 2003, and 39.5 at Tom's House in 2004.

Table 1. Results from Storm-petrel tape playback studies on Skomer 1981-2004 (brackets denote most recent data where sites were not visited).

Tabel 1. Resultaten van playback-studies aan Stormvogeltjes op Skomer 1981-2004. (tussen haakjes staan de meest recente data indien een studiegebied niet was bezocht).

	2004	2003	2001	2000	1998	1997	1996	1993	1981-82[1]
North Haven	13	13.8 (*n*=11)	8	11	21	17	10	(10)	5
Mew Stone	23.0 (*n*=2)	24.5 (*n*=2)	38	11	9	12	17	10	40
The Wick	3	-	-	-	-	-	-	-	-
Wick Basin	12	5	10	4	2	2	3	8	10
The Basin	0	2	0	1	0	2	2	(2)	10
Tom's House	17.4 (*n*=15)	11.2 (*n*=5)	9	6	3	4	8	6	20 incl. Amos
Above Tom's Hse	1	-	-	-	-	-	-	-	See above
The Amos	4	-	-	0	(2)	(2)	2	(2)	See above
TH West Gully	1	-	-	-	-	-	-	-	-
Skomer Head	1	-	-	-	-	-	-	-	-
Pigstone Bay	3	2	1	1	0	1	3	(3)	Not visited
The Spit	5	4	6	3	1	(1)	(1)	(1)	10
Littlewill Be.	20	14	7	7	0	(0)	(0)	(0)	Not visited
The Table	7	6	2	2	2	(2)	(2)	(2)	5
Paynes Ledges	0	0	0	0	-	-	-	-	-
Total	110.4	82.5	81	46	40	43	48	44	-
No. pairs[2] (95% CL)	251 (219-295)	303 (258-375)	388 (331-468)	220 (188-266)	192 (164-231)	206 (176-249)	230 (196-277)	211 (180-254)	

N.B. figures expressed to decimal places in 2003 and 2004 are means of a number of visits, thus giving an overall number of responses per visit. In 1996-1998, the highest figures from two visits were used, which would actually produce overestimates when multiplied by the correction factor. [1] *Pairs rounded up to nearest 5.* [2] *Number of pairs = responses x 2.27 in 2004, 3.67 in 2003, 4.79 rest*

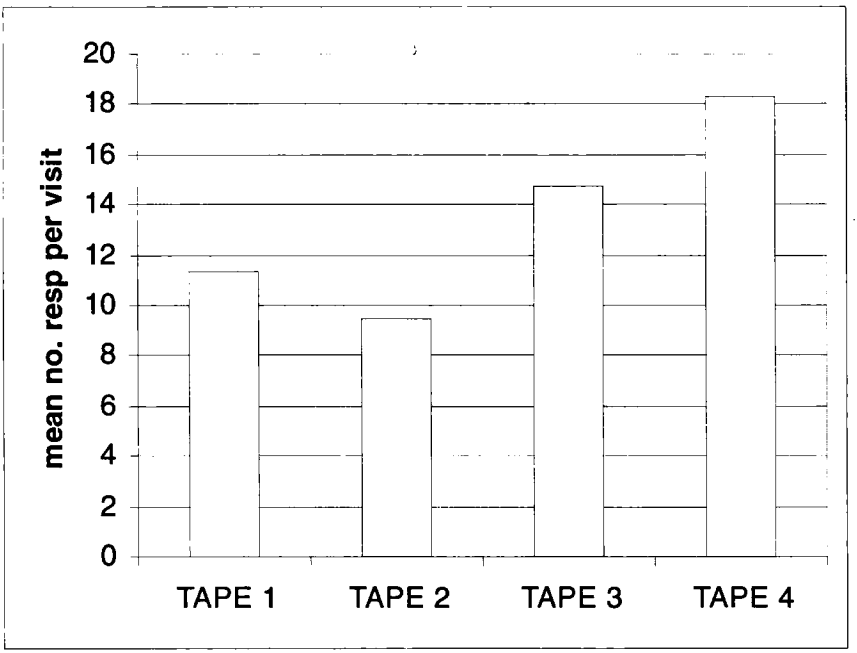

Figure 3. Effect of Tape Quality on Response-rate
Figuur 3. Effect van de kwaliteit van de geluidsopname op de antwoordfrequentie.

Replies from a mean of 13.8 nest sites were recorded per visit at North Haven (95% CL 11.4 - 16.2), giving a mean response-rate of 0.27 (95% CL 0.22 - 0.32). At Tom's House, a mean of 17.4 responses were elicited per visit (95% CL 14.8 – 20.0); a response-rate of 0.44 (95% CL 0.37 – 0.51).

Population estimates Responses were elicited from a mean of 82.5 sites in 2003 and 110.4 sites in 2004 (Table 1). The 2003 figure was just 1.5 up on 2001 overall (Table 1), but still the highest number of responses ever elicited on Skomer using this methodology. The 2004 figure was a further 33.8% rise.

Multiplying the mean number of responses by their respective correction factors (reciprocals of the response-rates i.e. 3.67 and 2.27) gives population estimates of 303 (95% CL 211-298) AOS in 2003 and 251 (95% CL 282 -398) AOS in 2004 (Table 1).

Effects of time of day, stage of survey period, and tape quality There was no effect of time of day on response-rate (ANOVA of response rate by 4-hour

period [0800-1200 etc.]; $F_{2,8} = 0.14$, P=0.9), nor July date ($r^2 = 0.17$, $F_{1,9} = 1.82$, $P = 0.21$).

Tape quality had a significant effect on the number of responses elicited (ANOVA $F = 5.98$, $P = 0.02$). More birds responded to Tape 4 (mean 18.3 responses, se 1.67) than tapes 1, 2 and 3 (with means of 11.3 [se 1.45], 9.5 [se 2.85] and 14.7 [se 1.67] respectively) (Fig 3), although Tape 3 ('hybrid' of 1 and 2) was not significantly different to the others (using Tukey's pairwise comparisons). Tape 4 also yielded the highest number of responses at Tom's House in 2003, and was used on the penultimate visit.

Chick responses Chicks responded to tapes (peeping call) at seven sites at North Haven in 2003, the first on 20 July, and three sites at Tom's House in 2004, first on 14 July. (Where chick calls were not accompanied by an adult, they were not registered as responses in the response-rate calculation). North Haven was revisited on 14 August 2003 to test the effect of such a late visit on response-rate, and to establish whether chicks responded alone to tapes (which would have implications on productivity measurement). Only one response was elicited and no chicks were heard.

DISCUSSION

Skomer Storm-petrel population The revised population estimates are considerably greater than those from previous playback surveys, as a result of the application of significantly higher correction factors than the 1.37 previously used (based on James'[1984] assumptions). There has also been a big increase in the actual number of responses obtained since 2000. The further big jump in 2004 (an increase of 33.8% on 2003) can be largely attributable to the consistent use of the most effective tape (Tape 4) throughout the 2004 survey period. In fact, 76.3% of that increase can be attributed to use of a better tape (based on the fact that Tape 4 elicited 35.5% more responses than the mean of Tapes 1,2 and 3, and Tape 4 was only used 27.2% of the time in 2003). Other causes of the observed increase in the number of responses elicited by playback in recent years are the discovery of new sub-colonies, and the cumulative search effort of previous surveys (many Apparently Occupied Sites from previous surveys are still marked, thus increasing search efficiency).

The results from years prior to 2003 have been revised by multiplying the number of responses by a correction factor equalling the inverse of the mean response-rate of Tapes 1 and 2, as it is assumed that these tapes were the ones used in previous surveys (Table 1). As they were the least effective tapes, a rather large correction factor of 4.79 (95% CL 4.09-5.78) is derived. A larger

potential for error must be borne in mind with these data, due to the smaller sample size and larger extrapolation.

Nevertheless, the estimated number of pairs of European Storm-petrel now breeding on Skomer is as high as 388, which could be regarded as a minimum as it is unlikely that all sites were found, and new sub-colonies continue to be discovered. With the population on Skokholm now thought to be as low as 1009 AOS (Thomson 2005), the Skomer Storm-petrel population is becoming a significant component of the Skomer and Skokholm SPA.

Chick responses and non-breeder bias The complete lack of chick responses on the mid-August visit suggests that chicks replied to tapes when newly hatched, but not when they were over seven days and no longer brooded by their parents. The reason for this may well be that a fidgeting parent, agitated by the intrusion of a tape played at the burrow entrance inadvertently wakes the chick and provokes begging. The chick would presumably only normally associate parental activity during 'changeover', when a feed would ensue. So, the chick is not responding directly to the tape, but to the tape-induced activity of the adult.

The mid-August visit showed a near-cessation of responding adults. While this demonstrates that this stage of the season is unsuitable for playback surveys, it also suggests that non-breeders occupying burrows at this time of year are not a significant bias. Ratcliffe *et al.* (1998) also found that non-breeding birds were unlikely to constitute a serious bias in estimation of breeding populations during diurnal playback surveys of European Storm-petrels.

Recommendations Tape quality is clearly highly important when conducting playback surveys. In order to provide as accurate an estimate as possible, the tape which is likely to produce the greatest number of responses should be consistently used. At the very least, response-rate measurement should be a part of every survey, to test tape efficiency and adjust the data accordingly.

North Haven and Tom's House are the most accessible large sub-colonies on Skomer, and their convenient contrasting habitat type and geographical locations render these sites suitable to test variations in response-rate further. The results from 2004 suggest that an asymptote may be reached as early as the seventh visit with the consistent use of a good quality tape (the two new sites discovered on the 13th visit may have been late pairs, non-breeders, or been overlooked on previous visits).

Once variations in response-rate (and their causes) are established, we will be closer to standardising the playback technique and hence repeatable censuses which will enable trends in the population to be monitored.

Results from tape playback surveys have contrasted strongly with ringing studies, with both techniques suffering from inherent biases. Further disadvantages of census by ringing include the necessity to access potentially dangerous areas at night, and disturbance of birds. Perhaps ringing should not be completely discounted, however, as a tool to compliment playback surveys, and provide data comparable with previous capture-mark-recapture studies.

ACKNOWLEDGEMENTS

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INVENTARISATIE VAN STORMVOGELTJE *HYDROBATES PELAGICUS* OP SKOMER

In 2003 en 2004 werden uitgebreide inventarisaties - met behulp van playback van geluidsopnames (playback-methode)- van Stormvogeltjes *Hydrobates pelagicus* uitgevoerd teneinde vergelijkbare schattingen te krijgen van het aantal broedpaar op Skomer. Het bepalen van de antwoordfrequentie door middel van meerdere herhaalde bezoeken aan twee subkolonies, elk in een jaar. In 2003 nam het cumulatieve aantal 'schijnbaar bezette nesten' (AOS) tijdens het elfde en laatste bezoek nog steeds toe. Derhalve werden de data geëxtrapoleerd om de asymptoot te berekenen. In 2004 vlakte de calibratieplot af na het 7e bezoek (waarschijnlijk als gevolg van gebruik van een effectievere geluidsopname, maar de ontdekking van een nieuw nest tijdens het dertiende bezoek resulteerde in een iets hogere asymptoot dan gevonden. De antwoordfrequenties van respectievelijk 0,27 en 0,44 waren significant lager dan voorheen werd gedacht, hetgeen leidt tot hogere populatieschattingen indien deze correctiefactoren worden toegepast. De populatie op Skomer wordt nu geschat op meer dan 300 AOS; waarmee Skomer een belangrijk onderdeel begint te worden van het Vogelrichtlijngebied (SPA) Skomer and Skokholm, zeker nu de populatie op het laatste eiland blijkbaar afneemt. De kwaliteit van de geluidsopname heeft een significant effect op het aantal 'uitgelokte' antwoorden, hetgeen belangrijke implicaties heeft voor toekomstige inventarisaties.

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